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The purpose of this research was to provide descriptive information on reading skill levels in the Navy that can be used when making decisions concerning implementation of any of the various options for minimizing functional illiteracy. A standard reading test was administered to all recruits (approximately 31,000) entering the Recruit Training Command, San Diego over a 1-year period. A significant proportion of the sample was found to have reading skills well below the difficulty of the manuals used in training. Reading

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skills were examined in relationship to rating assignments, the difficulty of rate training manuals, race, education, and Basic Test Battery Scores.

FOREWORD

This research was performed under Exploratory Development Task Area ZF55-522-011 (The Assessment and Enhancement of Prerequisite Skills) and Work Unit Number ZF55-522-011-03.01 (Language Skills: Assessment and Enhancement). This report is one in a series that will examine reading requirements, reading skill levels, and the effects of a mismatch of skills and requirements on school and job performance in the Navy. It describes the reading skills of a large sample of recruits and relates them to other skills, to background characteristics, and to subsequent career paths. The intent of the report is to provide descriptive information that can be used in making decisions regarding implementation of any of the options for reducing functional illiteracy.

The research in this Task Area seeks to enhance Navy training effectiveness by improving the match between the entering abilities of trainees and the abilities demanded by their curricula. The Work Unit is concerned with language skills that have the broadest application in terms of the training for which they are prerequisite.

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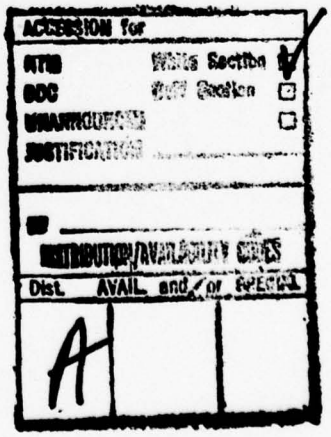
Preliminary results based on early samples from the data presented here were reported in NPRDC TR 77-15, entitled "Historical Antecedents and Contempory Trends in Literacy and Readability Research in the Navy." The findings presented herein have been extensively briefed to cognizant officials during the last 2 years and are published in the present form at this time primarily for reference purposes. These findings motivated the initiation of an Advanced Development Subproject: Z0108-PN.34, Prerequisite Skills Training System.

Appreciation is expressed to the staffs of the Naval Training Center and Recruit Training Command, San Diego, for providing access to the students and their records.

J. J. CLARKIN
Commanding Officer



SUMMARY

Problem

Recently there has been increasing concern that functional illiteracy may be increasing within the Navy. When a man does not have the reading skill necessary to effectively perform those reading tasks required in training and on the job, he is functionally illiterate. The concern arises from the fact that, while the reading skills of high school students are reportedly decreasing, the volume of printed materials supporting Navy systems has increased dramatically.

Purpose

This report is one of a series that will examine the reading requirements, reading skill levels, and the effects of a literacy mismatch on school and job performance in the Navy. The purpose of the present investigation was to provide descriptive information on reading skill levels throughout the Navy that can be used in making decisions regarding implementation of various options for minimizing functional illiteracy.

Method

The Gates-MacGinite reading test was administered to all available recruits (N = 31,575) entering recruit training between May 1974 and May 1975. Computer records were searched to obtain background information on the personnel and to obtain rating assignments.

Results and Discussion

A significant proportion of Navy recruits was found to have reading skills well below the reading difficulty level of the manuals they will encounter in training. Although 82 percent of the recruits were high school graduates, only 65 percent had reading skills at or above the 10th grade level. Indeed, within the sample there was a small correlation between amount of education and reading skill. The percentages of recruits in the major racial categories who read at or above the 10th grade level were: Caucasians, 70 percent; Blacks, 43 percent; and Malaysians (principally Filipinos), 21 percent.

It was found that the Navy's classification process tended to concentrate the poorer readers in the nondesignated ratings. Among the designated ratings, the lower ability readers were in the service specialties. However, there was a wide range of reading skills--from a 7.0 reading grade level (RGL) to at least a 12.0 RGL--in virtually every rating. This range of skills should be considered in preparing technical manuals; material written for the typical user may, in some cases, be well beyond the skill level of a large number of users. Twenty-one ratings were identified where at least 15 percent of the men tested had a reading skill at least two grade levels below the readability of the second class rate training manual.

Conclusions

1. The median reading ability measure for the sample of Navy recruits was 10.7 RGL.

2. Navy selection procedures in use at the time of this research did not adequately screen inept readers.

3. The higher the reading requirements for entrance into the Navy, the greater will be the proportion of Caucasian recruits.

4. Only 6.2 percent of the rating designated (or rated) men read below an 8.0 RGL, as compared to 33.8 percent of the nondesignated personnel.

Recommendations

1. Procedures should be developed to assess the skill required to perform each of the many different kinds of reading tasks found in the Navy (p. 17).

2. Research should be undertaken to determine the effects of a reading skill-reading difficulty gap on both training and job performance (p. 17).

3. A reading skill specification for accession into the Navy should be developed and implemented (p. 5).

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INTRODUCTION

Problem and Background

The Navy, historically, has considered reading skill to be essential to the maintenance of an effective and efficient force (Fletcher, Duffy, & Curran, 1977). Recently, however, there has been an increasing expression of concern as to the adequacy of the reading skills of the enlisted personnel relative to the difficulty of the reading tasks these men must perform on the job (Duffy, Carter, Fletcher, & Aiken, Note 1; Sticht & Zapf, 1976). The concern is based on the fact that, while reading skills are projected to decline, the volume of written materials in the Navy has increased dramatically. A decline in the reading skills in the recruit population may be projected simply on the basis of the national decline in reading skills of high school students (Harnischfeger & Wiley, 1975), who make up the bulk of Navy accessions. Independent of this national decline, recruit reading skills have been projected to decline as a by-product of the All Volunteer Force (Binkin & Johnston, 1973).

In contrast to the predicted decline in reading skills, the volume of written material has increased, both in training and on the job. For example, Muller (1976) reported that the pages of documentation required to support a modern Navy aircraft have increased in number from only 2,000 pages in 1950 to more than 260,000 pages in 1975. For all Navy systems, it has been estimated that 70 million pages of documentation have been published for operation and maintenance purposes alone. With the growth in printed technical documentation, there has almost certainly been a growth in the proportion of time a man must spend at reading tasks. Additionally, the material has likely grown more difficult due to the increasing use of high technology pervading the Navy.

Not all Navy personnel must have reading skills at the 14th grade level or even the 12th grade level--the levels of reading difficulty found for many Navy manuals (Biersner, 1975; Carver, 1974b). The amount and difficulty of reading faced by a seaman are very different from that encountered by a missile control technician. Indeed, the reading tasks will vary considerably within each of these job areas as a function of the specific assignment and the man's rate. However, each man must have the reading skills necessary to perform his particular job, and required for general day-to-day living in the Navy. A man unable to perform these necessary reading tasks is functionally illiterate either for his particular job or, more generally, for service in the Navy. The potential consequences of functional illiteracy vary considerably. At a minimum, the man will require direct supervisory instruction in the performance of his job. More extremely, the man may be a danger to himself and others. For example, many serious accidents during World War II were subsequently traced to the inability of the men to read safety and warning instructions. In addition, many disciplinary problems during that war reportedly grew out of the inability of the men to read station orders, watch bills, etc. (Special Training Program, Note 2).

If functional illiteracy in the Navy is to be minimized, then action must be taken to ensure a reasonable match of reading skills and reading requirements. There are many options available for ensuring this match (Aiken, Duffy, & Nugent, 1977; Duffy et al., Note 1). These options include: the selection and classification of personnel based on reading skills, the development of a literacy training system to provide training whenever it is required, and modification of the job situation either by simplifying the reading tasks or eliminating them. Determining which of these options or what mix of options will most effectively ensure functional literacy requires a detailed evaluation of specific Navy reading requirements and the reading skill levels of available personnel. This information would indicate where reading skill deficiencies, relative to job requirements, are most severe.

The research to date has emphasized the evaluation of reading requirements. It has included documentation of both the extent to which various kinds of written materials are used on the job (Post & Price, 1974; Sticht, Fox, Hauke, & Zapf, 1977) and the reading difficulty of the materials available for use on the job and in training (Biersner, 1975; Carver, 1974b; Fletcher et al., 1977; Kincaid, Fishburne, Rogers, & Chisom, 1975). In contrast, there has been relatively little research on the reading skill levels of personnel using the materials. The research that has been done has either focused on personnel with minimal reading skills (e.g., Hoiberg, Hysham, & Berry, 1974) or has involved samples of insufficient size for a detailed examination of reading skill in relationship to other variables (Carver, 1974a).

Purpose

This report is one of a series that will examine reading requirements, reading skill levels, and the effects of a mismatch of skills and requirements on school and job performance in the Navy. It describes the reading skills of a large sample of recruits and relates them to other skills, background characteristics, and subsequent career paths. The intent of the report is to provide descriptive information that can be used in making decisions regarding implementation of any of the options for reducing functional illiteracy, discussed previously.

METHOD

Reading Test

The testing was part of an effort by the Recruit Training Command, San Diego, to identify recruits with low reading skill by administering the vocabulary and comprehension subtests of the Gates-MacGinite Reading Test, Survey D (Gates & MacGinite, 1965). Thus, the reading-skill data reported here were derived from that test, even though it is not an ideal instrument for assessing the reading ability of adults. The test is empirically normed in grades 4 through 9 and grade-level norms have been extrapolated down to the second grade and up to the beginning of the twelfth grade. It was administered to all available male recruits entering recruit training in San Diego between 13 May 1974 and 30 May 1975.

Test administration during the 1-year period became a part of the standard processing of recruits during their first week in the Navy. The test was administered by Navy personnel, following standard procedures, to groups of 50 to 140 recruits each day. The recruits occupied individual test carrels in a large, quiet room.

Of the 32,890 men entering recruit training at San Diego during the time of the experiment, 96 percent (31,575 men) were administered the reading test. The 4 percent that were not tested had either been discharged by the time of testing or were sick on the test day.

Other Personnel Data

Using social security numbers to identify the recruits, Navy personnel records were searched twice. The first search, which was made shortly after administration of the reading test, provided complete background information and entrance test data for 87 percent of the subjects given the reading test. Failure to obtain all background data for the remaining 13 percent was due primarily to inaccurate recording of social security numbers at the time the reading test was administered. The second search, which was made approximately 1 year after the last administration of the reading test, provided information as to the man's rate, rating, and technical training.

The entrance test data obtained on the sample during the first search included scores obtained on the Navy Basic Test Battery (BTB), a battery of six subtests used to classify Navy personnel, and two scores derived from the BTB: the Armed Forces Qualification Test (AFQT) score and the classification of the man as to his mental ability. The BTB subtests for which scores were obtained were:

- General Classification Test (GCT), a test of general ability involving verbal analogy and sentence completion items.
- Arithmetic Reasoning Test (ARI), a test of mathematical reasoning involving word problems.
- Mechanical Ability (MECH), a test of comprehension of mechanical principles using illustrated items.

- Clerical Test (CLER), a test of speed and accuracy in searching for specified digits.

- Electronics Test (ETST), a test of electronic aptitude in solving word problems.

In addition to the above test scores, self-reported years of education and race were obtained from the records.

RESULTS AND DISCUSSION

Distribution of Reading Test Scores

The test norms were used to convert the raw scores on the reading test to reading grade level (RGL) scores. An RGL score refers to that grade level in school at which one would expect students to obtain a particular raw score. For example, a recruit achieving a 6.0 RGL on this test has performed at a level equivalent to that of the average student beginning 6th grade at the time the norms were developed.

Among the norm groups of the Gates-MacGinite test, the coefficients of correlation between scores obtained on the vocabulary and comprehension subtests range between .67 and .83. In this study, the correlation was considerably lower: $r = .48$. The relatively low correlation between subtest scores was probably a result of the low maximum score (12.0 RGL) that can be attained on this test, because this ceiling score limits the test's capability to measure individual differences among good readers. For example, if the actual abilities of the good readers ranged between 11.0 and 16.0 RGL, their scores on this test would range between 11.0 and 12.0 RGL. This reduced variance would in turn be reflected in lower correlation coefficients.

As can be seen in the distributions of subtest scores shown in Table 1, the expected ceiling effect did occur. On the vocabulary subtest, 29 percent of the recruits scored between 11.0 and 12.0 RGL, and on the comprehension subtests, over 60 percent scored in this upper range. The truncation of scores can be seen more clearly in Figure 1, which shows the percentage of recruits who scored at or above a given RGL on the two subtests. Figure 1 also shows that the distributions were fairly comparable up to the 8th grade level. For purposes of this report, we derived a general index of reading ability by taking the average of the two subtest RGL scores as the basic measure.

The RGL distribution, shown in the bottom row of Table 1, indicates that 18.1 percent of the sample had a score below an 8th grade level. If this percentage can be generalized in all FY 1975 accessions, it would indicate that almost 19,000 men entering the Navy during that year read below an 8.0 RGL. In comparison, the manuals for recruit training and follow-on apprentice training were written at the 11th and 12th grade level (Biersner, 1975). Thus, there was a gap of at least three grade levels between reading skills and formal reading requirements for 18 percent of the recruits. Since these men were clearly deficient in reading skills relative to the formal requirements, they could be expected to have difficulty completing basic training in which formal reading requirements had to be met. Some of these men, those reading below the 4.0 RGL, would not be able to decode even highly familiar one-syllable words, as found in basic signs and directions, and thus would be classified as functionally illiterate if any reading at all was required. These men constituted 2.1 percent of the sample or a projected 2,100 accessions in FY 1975.

Table 1

Cumulative Percentage Distribution of Vocabulary, Comprehension, and the Average of the Vocabulary and Comprehension Reading Grade Level (RGL) Scores for the Total Sample (N = 31,575)

Test	Median RGL Score	Reading Grade Level								
		<4.0	<5.0	<6.0	<7.0	<8.0	<9.0	<10.0	<11.0	<12.0
Vocabulary	9.9	1.9	4.4	7.4	13.7	18.8	30.7	52.3	71.0	100.0
Comprehension	11.9	2.8	5.6	9.6	13.8	18.5	26.1	31.7	39.3	100.0
Average	10.7	2.1	4.1	7.7	12.2	18.1	25.3	35.8	54.2	100.0

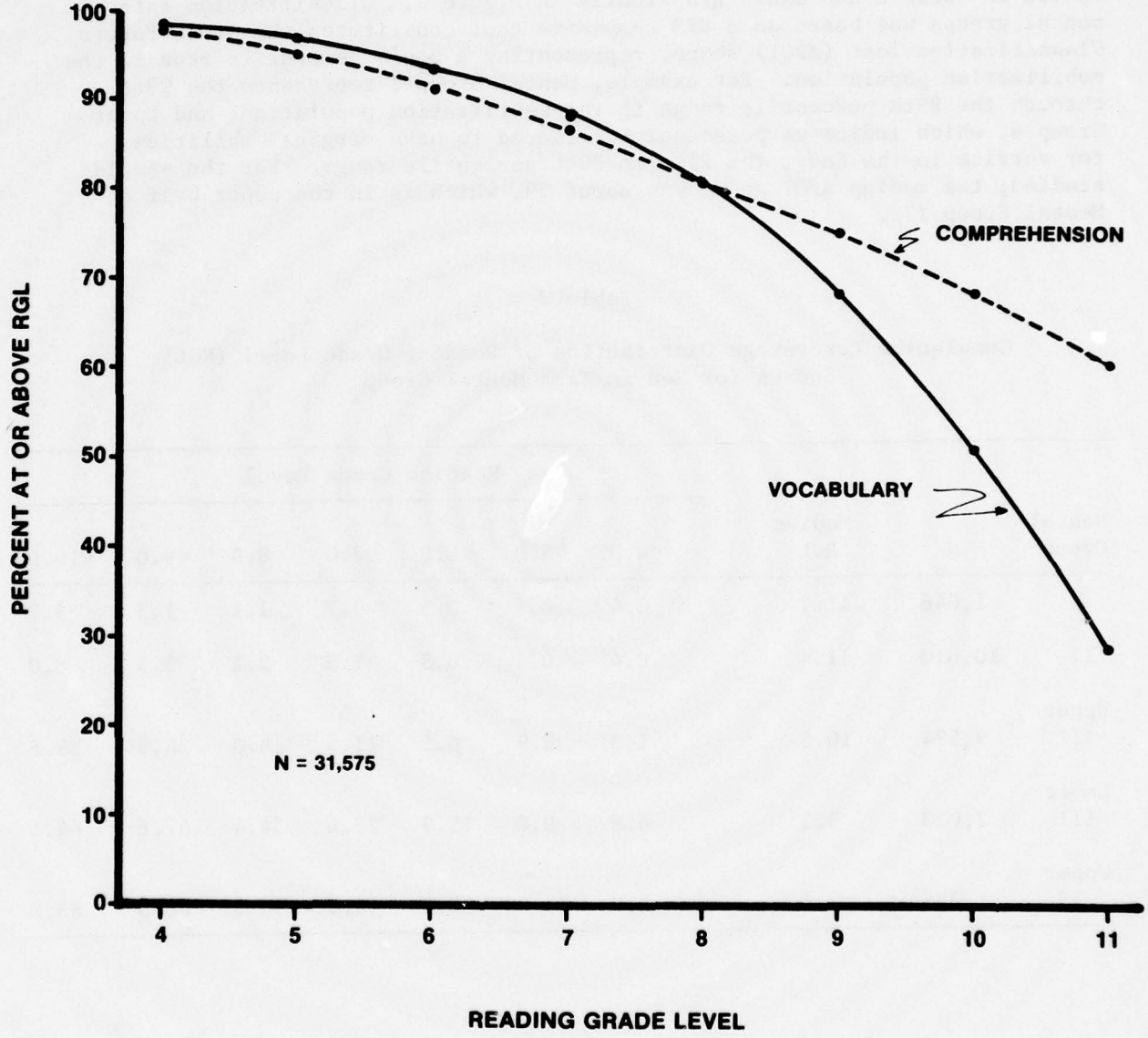

Figure 1. Percentage of recruits scoring at or above a given reading grade level (RGL) on the vocabulary and comprehension subtests.

Mental Group

The distribution of reading scores within each mental group is presented in Table 2 and shown graphically in Figure 2. Classification into mental groups was based on a BTB composite that constitutes the Armed Forces Classification Test (AFQT) score, representing a man's percentile rank in the mobilization population. For example, Mental Group 1 represents the 93rd through the 99th percentile range in the mobilization population; and Upper Group 4, which indicates personnel considered to have marginal abilities for service in the Navy, the 21st to 30th percentile range. For the sample studied, the median AFQT score was about 59, which is in the upper half of Mental Group III.

Table 2

Cumulative Percentage Distribution of Reading Grade Level (RGL) Scores for Men in Each Mental Group

Mental Group	N	Median RGL	Reading Grade Level						
			<4.0	<5.0	<6.0	<7.0	<8.0	<9.0	<10.0
I	1,046	11.7	0.4	0.4	0.5	0.7	1.1	1.5	3.7
II	10,810	11.4	0.4	0.5	0.8	1.3	2.1	3.7	8.0
Upper III	9,574	10.5	1.3	2.9	6.5	11.5	18.0	26.6	39.8
Lower III	7,010	9.1	4.8	9.0	15.9	23.6	34.4	47.6	64.4
Upper IV	1,338	7.6	8.8	16.0	27.3	40.5	55.6	68.3	83.2

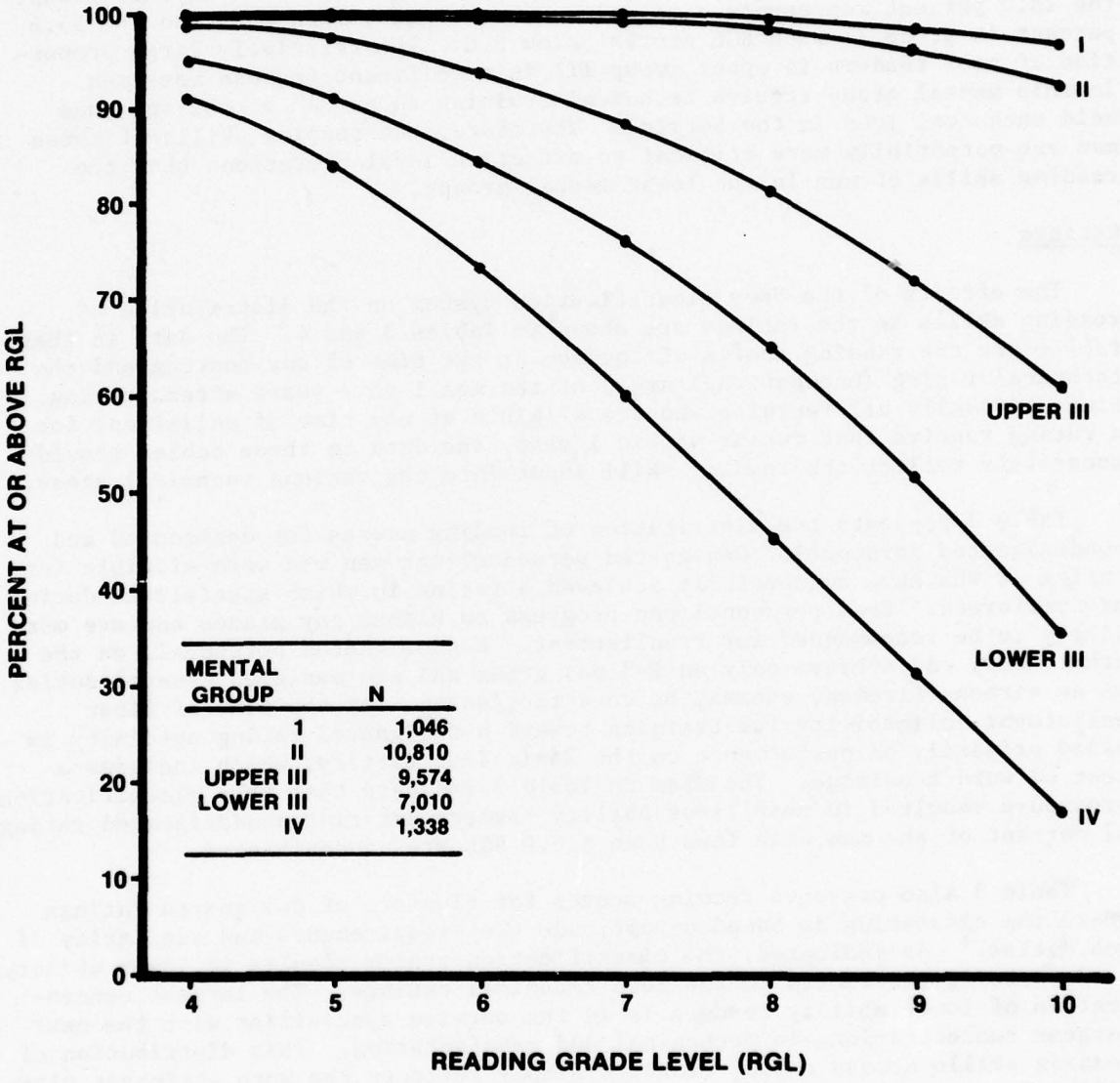

Figure 2. Percentage of recruits in different mental groups scoring at or above a given RGL.

Since mental ability and reading skill tend to be highly correlated, the increase in the proportion of low ability readers in the lower mental groups, as indicated in Table 2, was expected. However, an unexpectedly large proportion of men (18.0%) in upper group III was found to have a reading score below 8.0 RGL. Since almost a third of the recruit input was in this group, the 18.0 percent represents a sizable number of men, more men than the 55.6 percent in group IV with RGL scores below 8.0. The relatively large proportion of poor readers in upper group III is significant because most men in this mental group receive technical training in an "A" school and thus hold technical jobs in the service. Therefore, the reading skills of these men are potentially more critical to effective naval operations than the reading skills of men in the lower mental groups.

Ratings

The effects of the Navy classification system on the distribution of reading skills in the ratings are shown in Tables 3 and 4. The data in these tables are the reading scores of the men at the time of our testing and the technical rating (occupational area) of the men 1 to 2 years after testing. Since virtually all recruits who are eligible at the time of enlistment for a rating receive that rating within 1 year, the data in these tables should accurately reflect the reading skill input into the various technical areas.

Table 3 presents the distribution of reading scores for designated and nondesignated personnel. Designated personnel are men who were eligible for rating or who have successfully achieved a rating in which specialized duties are performed. Such personnel can progress to higher pay grades and are more likely to be recommended for reenlistment. Nondesignated personnel, on the other hand, can achieve only an E-3 pay grade and are assigned general duties as an airman, fireman, seaman, or constructionman. At the time of first enlistment, eligibility for training toward a designated rating specialty is based primarily on performance on the Basic Test Battery, which includes a test of word knowledge. The data in Table 3 indicate that this classification procedure resulted in most lower ability readers entering nondesignated ratings; 87 percent of the men with less than a 6.0 RGL are nondesignated.

Table 3 also presents reading scores for clusters of designated ratings where the clustering is based on aptitude test requirements and similarity of job duties.[1] As indicated, the classification system results in lower ability readers being restricted to the less technical ratings. The largest concentration of lower ability readers is in the service specialties with the next largest concentrations in mechanical and manufacturing. This distribution of reading skills across rating clusters simply reflects the more stringent classification requirements for the more technical ratings. Since reading skill tends to be highly correlated with aptitude test scores (Singer, Note 3), the greater reading skills in the more technical ratings are to be expected. However, it should not be assumed that the less technical ratings impose fewer or easier reading requirements (Aiken, Duffy, & Nugent, 1976; Biersner 1975).

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[1]This clustering scheme is used in recruiting and the ratings within each cluster are reported in Navy Careers 1976-1977, Recruiting Advertising Department.

Table 3

Cumulative Percentage Distribution of Reading Grade Level (RGL) Scores for Personnel in Subcategories of Designated and Nondesignated Ratings

Rating Category	N	Median RGL	Reading Grade Level <6.0	<7.0	<8.0	<9.0	<10.0
Designated							
Service	848	10.2	6.4	11.7	19.9	29.6	45.0
Manufacturing	85	10.7	2.4	2.4	4.7	14.1	30.6
Construction	1,331	10.9	2.0	4.0	8.2	14.9	26.5
Mechanical & Repair	4,180	10.9	2.6	5.3	9.9	16.7	28.6
Clerical & Admin.	785	11.1	2.0	4.7	10.3	16.4	26.4
Transportation Field	608	11.2	1.8	2.5	4.1	8.9	16.1
Data Processing	122	11.4	0.8	0.8	0.8	4.1	6.6
Health	1,583	11.4	1.0	3.0	5.7	9.5	16.4
Scientific & Tech.	7,358	11.4	0.7	1.4	2.9	5.9	12.0
Social Science	307	11.4	0.7	2.0	4.2	7.2	15.0
Communications	169	11.6	0.6	1.2	1.2	2.4	5.9
Total	17,396	11.2	1.7	3.4	6.4	11.3	20.0
Nondesignated							
Fireman	3,155	8.6	19.2	29.4	41.6	54.5	68.8
Airman	1,827	9.2	14.2	23.6	33.6	45.3	59.7
Seaman	7,641	9.7	14.9	22.2	31.0	40.4	52.7
Constructionman	123	10.7	7.3	7.3	11.4	18.7	29.3
Total	12,746	9.3	15.8	24.0	33.8	44.4	57.4

Table 4

Cumulative Percentage Distribution of Reading Grade Level (RGL) Scores of Men and the RGL Difficulty Score (from Biersner, 1975) for the 3rd and 2nd Class Rate Training Manual in Navy Ratings

Rating	No. of Men	Manual RGL	RGL				
			<6.0	<7.0	<8.0	<9.0	<10.0
Deck Personnel							
Quartermaster (QM)	255	10.9	1.2	1.2	1.2	3.1	7.1
Signalman (SM)	119	11.5	2.5	5.0	9.2	12.6	18.5
Operations Specialist (OS)	455	12.3	0.4	0.4	1.1	2.8	8.6
Electronics Warfare Tech. (EW)	58	13.9	0.0	0.0	0.0	0.0	1.7
Sonar Technician Surface (STG)	185	12.7	1.1	1.6	2.2	2.2	5.9
Sonar Technician Subsurface (STS)	129	11.2	0.0	0.0	0.0	3.1	6.2
Ocean Systems Tech. (OT)	64	--	0.0	0.0	1.6	7.8	12.5
Ordnance Personnel							
Torpedoman's Mate (TM)	214	10.3	0.9	2.3	4.2	7.5	14.5
Gunner's Mate Missiles (GMM)	69	10.2	0.0	0.0	0.0	8.7	11.6
Gunner's Mate Technician (GMT)	73	--	1.4	4.1	4.1	6.8	15.1
Gunner's Mate Gun (GMG)	132	11.0	0.0	0.0	3.0	8.3	17.4
Fire Control Tech. Gun (FTG)	326	12.1	1.2	1.5	2.5	4.9	9.2
Fire Control Tech. Surface Missile (FTM)	206	11.2	1.0	1.0	1.5	2.4	10.2
Fire Control Tech. Ballistic	69	12.1	0.0	0.0	0.0	0.0	2.9
Missile Technician (MT)	135	14.1	0.0	0.0	0.7	2.9	4.4

Table 4 (Continued)

Rating	No. of Men	Manual RGL	RGL <6.0	<7.0	<8.0	<9.0	<10.0
Electronics Personnel							
Electronics Technician Communication (ETN)	445	12.9	0.4	0.7	0.9	2.2	5.2
Electronics Technician Radar (ETR)	346	12.9	0.3	0.3	0.9	1.2	4.0
Data Systems Technician (DS)	180	13.5	0.0	0.6	0.6	3.9	8.9
Administrative and Clerical Personnel							
Radioman (RM)	722	12.6	0.7	1.8	4.7	9.8	19.8
Communications Technician Technical (CTT)	138	13.4	0.0	0.0	0.0	1.4	11.6
Communications Technician Administrative (CTA)	32	14.9	0.0	3.1	3.1	9.4	15.6
Communications Technician Maintenance (CTM)	86	14.1	0.0	0.0	1.2	2.3	3.5
Communications Technician Communications (CTO)	104	12.7	0.0	0.0	1.9	2.9	7.7
Communications Technician Collections (CTR)	107	13.4	0.9	0.9	1.9	4.7	12.1
Yeoman (YN)	187	13.5	0.5	0.5	4.3	7.0	13.4
Personnelman (PN)	307	13.2	0.7	2.0	4.2	7.2	15.0
Data Processing Tech. (DP)	122	12.5	0.8	0.8	0.8	4.1	6.6
Storekeeper (SK)	354	13.7	2.3	6.5	15.0	23.7	35.9
Disbursing Clerk (DK)	99	14.3	3.0	5.1	11.1	16.2	31.3
Mess Management Specialist (MS)	571	11.0	6.5	11.0	17.9	28.4	42.9
Information Security Specialist (IS)	52	--	0.0	0.0	0.0	0.0	3.8
Ship's Serviceman (SH)	277	12.9	6.1	13.0	24.2	32.1	49.5
Journalist (JO)	30	12.1	0.0	0.0	0.0	0.0	0.0
Postal Clerk (PC)	36	13.6	0.0	2.8	5.6	5.6	13.9

Table 4 (Continued)

Rating	No. of Men	Manual RGL	RGL <6.0	<7.0	<8.0	<9.0	<10.0
Engineering and Hull Personnel							
Machinist's Mate (MM)	1,390	12.3	2.2	4.5	7.8	13.6	23.2
Engineman (EN)	532	11.2	2.8	4.9	9.2	16.0	27.3
Machinery Repairman (MR)	159	10.5	1.3	3.8	9.4	15.7	30.2
Boiler Technician (BT)	749	11.8	3.6	8.1	14.4	23.2	36.7
Electrician's Mate (EM)	854	12.5	1.4	3.2	6.6	11.1	18.4
Interior Communications Electrician (IC)	392	12.6	0.0	0.8	2.3	4.6	9.7
Hull Maintenance Tech. (HT)	734	10.7	2.0	4.0	7.6	14.4	26.0
Construction Personnel							
Construction Electrician (CE)	83	10.9	2.4	3.6	9.6	14.5	25.3
Equipment Operator (EO)	221	11.3	1.8	4.1	10.4	16.3	28.5
Construction Mechanic (CM)	113	10.4	2.7	3.5	8.0	19.5	31.0
Builder (BU)	177	11.0	0.6	2.8	5.6	12.4	24.3
Steelworker (SW)	46	10.1	0.0	0.0	4.3	17.4	28.3
Utilitiesman (UT)	87	12.2	3.4	5.7	10.3	18.4	29.9
Aviation Personnel							
Aviation Machinist's Mate Reciprocal Engines (ADR)	31	12.5	3.2	9.7	9.7	9.7	12.9
Aviation Machinist's Mate Jet Engines (ADJ)	627	12.2	0.6	1.8	4.8	10.8	20.7
Aviation Electronics Technician (AT)	358	13.0	0.3	.9	1.1	2.8	5.9
Aviation ASW Technician (AX)	144	12.9	0.7	1.4	1.4	2.8	9.0
Aviation ASW Operator (AW)	176	12.6	0.6	.6	.6	1.1	3.4
Aviation Ordnanceman (AO)	293	12.2	1.0	2.0	6.8	13.0	28.0
Aviation Fire Control Technician (AQ)	89	12.5	0.0	0.0	0.0	1.1	4.5
Air Traffic Controlman (AC)	82	14.1	0.0	0.0	0.0	2.4	6.1
Aviation Boatswain's Mate Launching & Recovery (ABE)	64	12.8	1.6	3.1	7.8	15.6	29.7

Table 4 (Continued)

Rating	No. of Men	Manual RGL	RGL <6.0	<7.0	<8.0	<9.0	<10.0
Aviation Personnel (Cont.)							
Aviation Boatswain's Mate Fuels (ABF)	52	11.3	3.8	3.8	7.7	11.5	23.1
Aviation Boatswain's Mate Aircraft Handling (ABH)	86	11.3	5.8	7.0	10.5	23.3	31.4
Aviation Electrician's Mate (AE)	385	12.9	0.3	1.0	2.3	8.1	16.4
Aviation Structural Mechanic Structures (AMS)	355	11.3	3.1	6.5	12.7	18.9	31.8
Aviation Structural Mechanic Hydraulic Mechanic (AMH)	370	11.8	3.2	6.2	10.3	17.3	31.9
Aviation Structural Mechanic Safety Equipment (AME)	155	12.8	3.2	6.5	11.6	18.7	29.0
Aircrew Survival Equipmentman (PR)	68	11.5	0.0	2.9	5.9	11.8	25.0
Aerographer's Mate (AG)	65	12.7	1.5	1.5	1.5	1.5	4.6
Aviation Storekeeper (AK)	72	15.5	4.2	8.3	9.7	16.7	23.6
Aviation Maintenance Administration (AZ)	41	15.1	2.4	2.4	2.4	2.4	4.9
Photographer's Mate (PH)	47	11.4	0.0	0.0	0.0	2.1	4.3
Medical Personnel							
Hospital Corpsman (HN) (also includes apprentices (HA))	1,239	--	0.7	2.6	5.1	8.2	15.1
Dental Personnel							
Dental Technician (DT) (also includes apprentices (DA)	164	--	4.3	9.1	15.9	25.0	34.1

The distribution of reading scores in each Navy rating for which there were at least 30 scores is presented in Table 4. These distributions should serve as important data points for specifying a reading difficulty criterion for the preparation of manuals. Currently, the reading skills of the projected users of a manual are specified in a summary fashion such as ". . . the level of writing should be for a high school graduate having specialized training as a technician . . ." (MIL-M-24100B, 1974). While most Navy recruits are high school graduates, the data in Table 4 indicate that reading skill is well below the 13.0 RGL (high school graduate) for many men in the ratings.

The full distribution of reading scores in a rating cannot serve as a specification for the preparation of a manual. A cut score or a criterion is needed that states the proportion of men in a rating who should be able to read and comprehend the manual. For example, one could specify that manuals should be prepared for the average user. However, because of the considerable variance of reading skills, even within ratings, many manuals would be written well beyond the reading skill of a significant number of men. The average reader in the sample of aviation structural mechanics (AMS) had a reading test score of 10.5 RGL, but almost 13 percent of the men in the rating scored below 8.0 RGL. Thus, a manual written for the average user in this rating would exceed the reading skill of 13 percent of the men by at least 2.5 grade levels.

An alternative RGL criterion for manual preparation could be to write for the least skilled reader in the rating so that everyone would be able to use the manual. However, since there are men with less than a 6.0 RGL in most ratings, writing to this skill level would be extremely costly. It would likely result in a considerable increase in the volume of materials due to the increased elaboration of textual information, the increased use of graphics to supplement text, and the need to use many simple words in place of complex terms.

A proposal resulting from a CNO (OP-099) conference[2] on the readability of Navy manuals was that manuals be written at a level one standard deviation below the mean reading skill of the intended users. This proposal takes into account both the typical reading skill and the variability of reading skill in rating. It is a compromise between writing to the average user and writing to the least skilled user. One standard deviation below the mean would include roughly 84 percent of the users. Therefore, under this criterion most of the manuals for nondesignated personnel would be written to the 6th grade level since, as can be seen in Table 3, roughly 84 percent of the men in seaman, fireman, and airman ratings read at or above the 6.0 level. When this criterion is applied to the distributions shown in Table 4, we can see that the approximate reading skill of the targeted user would range from about 7.0 RGL for the ship's serviceman rating, and about 8.0 RGL for the storekeeper, boiler technician, and aviation structural mechanic ratings, to levels above 10.0 RGL for such ratings as electronics technician, information security specialist, and aviation ASW operator.

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[2]OP-99 speedletter 991b/550 of 13 March 1974.

The discussion thus far has dealt with only one data source, the distribution of reading skills, in specifying reading difficulty levels for manuals. However, as Fletcher et al. (1977) have indicated, the reading skill of the user is only one of a host of variables relevant to the specification of a difficulty level. A major component of the human factors work in the Navy Technical Information Preparation Program (Sulit & Fuller, 1976) is the determination of the full range of personnel and job characteristics that influence the ease of using a manual. Job characteristics directly relevant to the specification of a reading difficulty criterion are the repetitiveness of the reading tasks, the time available for reading, the purpose of the reading, and the volume of reading. For example, the application of the standard deviation criterion to the reading skill distribution for a rating may indicate the target level for the manual should be 8.0 RGL; but, if the manual is primarily used as an information source in doing a familiar job, a higher (more difficult) reading difficulty level would likely be acceptable. On the other hand, if the manual is used primarily in learning about new jobs and the amount of reading is considerable, then a lower difficulty level might be desirable. Research is required to determine the specific effects of use conditions on the tolerable gap between the difficulty level of the manual and the reading skill of the user.

The third column on Table 4 presents the reading difficulty level for the 3rd class and 2nd class rate training manual for each of the ratings. These manuals are frequently used as "A" school texts and in all cases serve as the source books for preparing for the written examinations for advancement in rate (pay grade). The difficulty levels, in RGL units, were calculated by Biersner (1975), who used a readability index normed on Navy men and materials and, therefore, accounted for the familiarity of technical words within the Navy.

None of the manuals received less than a 10.0 RGL difficulty score; the range was from 10.1 RGL for the steelworker manual to 15.5 RGL for the aviation storekeeper manual. We could not assess the proportion of men in a rating who read at or above the difficulty of some of the manuals because the reading test had a ceiling score of only 12.0 RGL. However, even with that limitation, there were still 15 ratings in which at least 15 percent of the men in the rating had a reading ability score less than the 10th grade level and a manual difficulty level at or above the 12th grade level (Table 4). Whether or not these deficiencies affect performance must be the subject of further research. In this regard, Kulp (Note 4) examined the relation between reading skill and performance of an unfamiliar industrial task. In Kulp's study, a manual was the only information source available for performing an experimentally simulated industrial task. She found that, when the gap between reading skill and the difficulty of the supporting manual exceeded two RGLs, there were significant performance deficiencies. Kulp's task simulation was much like the situation encountered by a new man on the job. Similar research is required to specify the tolerable gap for the trainee, the experienced worker, and the supervisor under all of the various conditions of using a manual.

Education

The median number of years of education completed by the personnel in our sample was 12.3, somewhat beyond the completion of high school. Education

levels ranged from eighth grade through the attainment of graduate degrees. A Pearson product moment correlation coefficient of .13 was obtained between years of education and reading test score. That is, for this sample, years of education accounted for less than 2 percent of the variance in reading test performance. Of all of the test and background information for which we had data, years of education showed the least relationship to reading skill. In contrast to the present findings, recent evaluations of adult reading skills in the United States indicate that, when the full range of effect on reading levels is adequately represented, education is highly predictive of adult reading ability. In studies by Northcutt, Selz, Shelton, Nyer, Hickok, and Humble (1975) and Young and Jamison (1975), a reading test was administered to a large, representative sample of U.S. adults. In both studies, education level was the demographic variable that most strongly predicted reading skill. The discrepancy between the results of these studies and the present findings is most likely due to the selection criteria for entrance into the Navy. That is, men with little education usually are not recruited. For example, two-thirds of our sample completed exactly 12 years of education while another 13 percent completed exactly 11 years. This restriction in the variance of years of education would result in a smaller correlation with reading skill.

Figure 3 presents the distribution of reading scores for high school graduates and nongraduates. Again, there was little difference in education levels for the two groups--a median of 11.1 years for the nongraduates and 12.5 for the graduates. There is a wide range of reading skill levels in both groups. The wide range of reading skills for high school graduates indicates that a selection policy of accepting only high school graduates will not "solve" a reading problem in the Navy.

Race

Figure 4 presents the distribution of reading test scores for each of the three major race categories. Approximately 1.5 RGL's separate the median scores of the groups, with Caucasians having the highest median (11.0) and Malaysians the lowest (7.6). The same ranking of the races is obtained in a comparison of the proportion of men reading below the 8th grade level. However, in terms of absolute numbers, the men with reading scores below 8.0 RGL are primarily Caucasians and Malaysians. The distinction between the proportional vs. absolute number of lower ability readers is important in the consideration of any action to deal with reading skills. For example, although a successful reading training program would primarily affect the mean reading skill of the Malaysian and Black racial groups, the students in the program would be primarily Caucasian and Malaysian. A reading skill selection process, on the other hand, would reject more Caucasians than any other racial groups; but, at the same time, would increase the proportional representation of Caucasians in the Navy.

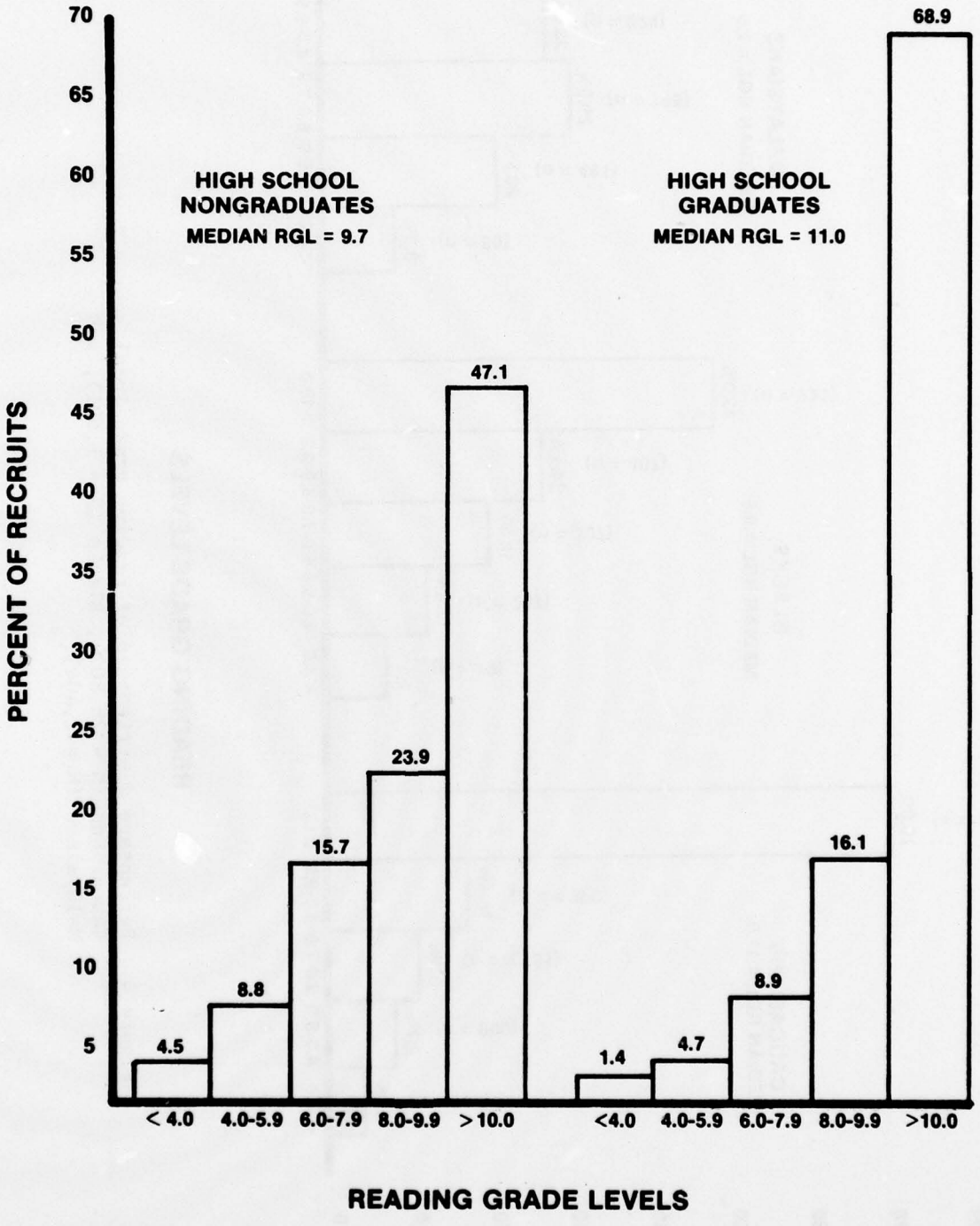

Figure 3. Percentage of reading grade level (RGL) scores for recruits who did (N = 24,227) and did not (N = 5,437) graduate from high school.

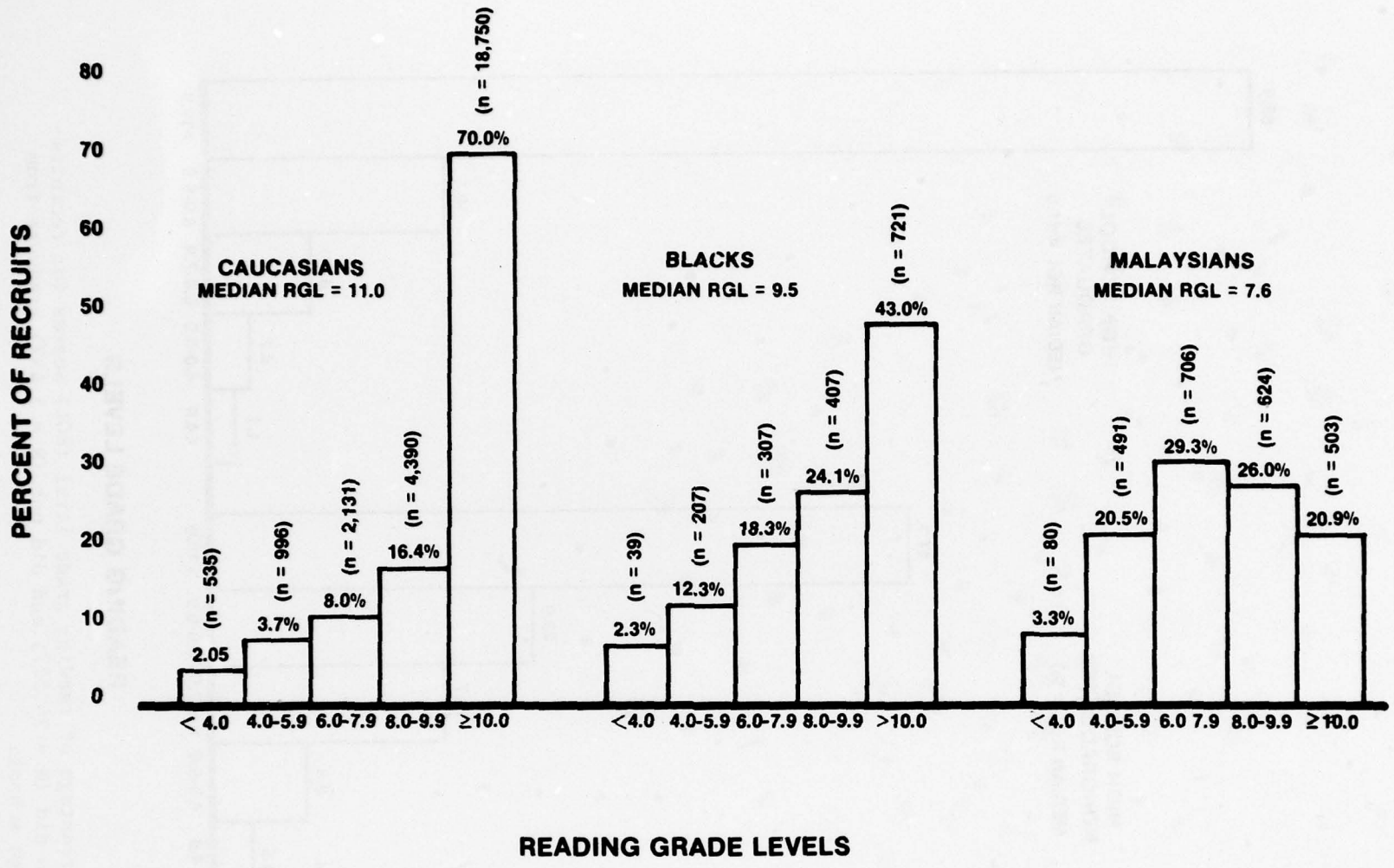

Figure 4. Percentage distribution of reading grade level scores for Caucasians (N = 26,802), Blacks (N = 1,681), and Malaysians (N = 2,404).

The data in Figure 4 suggest a major cause of many of the reading problems at the San Diego RTC. The Malaysians, while only 8.0 percent of the sample, represent 23 percent of the sample with reading scores below 8.0 RGL. The Malaysians also constitute a group in which English is a second language for most. Although English is taught beginning in the first grade in the Malaysian countries, its use is typically restricted almost entirely to the school. While the San Diego RTC receives the majority of Malaysian recruits, the other training centers receive considerable numbers of men for whom Spanish is the native language. Thus, a high proportion of the lower ability readers at all the training centers can be expected to have English as a second language.

Intercorrelations

The mean for each aptitude, ability, and background variable in our data set and the intercorrelations of these variables are presented in Table 5. Reading test performance correlated most strongly with those aptitude tests requiring reading. The strongest relationship was with GCT ($r = .72$) which is a verbal analogy and sentence completion test. Since GCT, ARI, and MECH are the primary tests for determining eligibility for specific "A" schools in the Navy, the effects of the classification process on the distribution of reading skills, as shown in Table 3, are understandable. Interestingly, reading test performance was only moderately correlated with AFQT scores ($r = .57$). Thus, general ability, as measured by the AFQT, only accounted for 32 percent of the variance in reading test scores.

Table 5

Intercorrelation Matrix of Reading Ability
and Selected Personnel Data

Variable Name	N	Mean	Standard Deviation	Variable 1	2	3	4	5	6	7
Gates-MacGinite Reading Average	31,575	9.9	2.2	-	.13	.57	.72	.50	.41	.44
Years of Education Completed	30,677	11.9	1.1	.13	-	.25	.18	.27	-.03	.30
Armed Forces Qualification Test Score	29,778	60.0	19.2	.57	.25	-	.77	.74	.61	.63
General Classification Test Score	28,754	53.3	9.4	.72	.18	.77	-	.66	.48	.58
Arithmetic Reasoning Test Score	28,664	51.2	8.4	.50	.27	.74	.66	-	.39	.65
Mechanical Comprehension Test Score	28,611	51.8	8.1	.41	-.03	.61	.48	.40	-	.38
Electronics Selection Test Score	28,605	54.1	11.9	.44	.30	.63	.58	.65	.38	-

CONCLUSIONS

The following conclusions may be drawn from the above results:

1. The median reading skill for a large sample of Navy recruits at RTC San Diego was 10.7 RGL. One-fourth of the men in the sample read at least two RGL's below the difficulty of the recruit and apprentice training manual, indicating these men may not be able to independently read and comprehend these basic Navy manuals.

2. Navy selection instruments in use at the time of this research did not adequately screen inept readers from the service. Of the sample tested, 2.1 percent read below the 4.0 RGL. Clearly, these men did not have the reading skill to perform even day-to-day reading tasks in the Navy.

3. Since reading skill distributions differ by race, selection or classification policies based on reading skill will affect the racial make-up of the service. The higher the reading requirement for entrance into the Navy, the greater will be the proportion of Caucasian recruits.

4. Most lower ability readers are not rated or rating designated after 1 year in the service. The median RGL for rating designated men was 11.2. Only 6.2 percent of these men read below 8.0 RGL, as compared to 33.8 percent of the men in nondesignated ratings. The men with less than an 8.0 RGL were found in most of the ratings examined, but tended to be concentrated in the less technical ratings (e.g., 25% in the ship's serviceman rating and 11% in the aviation boatswain's mate fuels rating scored below an 8.0 RGL).

5. Fifteen ratings were identified in which significant numbers of men read two or more grade levels below the difficulty of the 3rd class rate training manual for that rating. A deficiency of this magnitude has been found to significantly degrade job performance; therefore, it is likely that these men do not have the skills necessary to fully comprehend their manuals. To fully assess the adequacy of reading skills, the volume of reading, time to read, purpose of reading, and correlation with course/job performance must be assessed.

RECOMMENDATIONS

The following recommendations are made based on the above results and conclusions:

1. Procedures should be developed to assess the skill required to perform each of the many different kinds of reading tasks found in the Navy. A standard, general reading test was used in the present research because it was the best instrument available. However, in addition to reading paragraphs, men read tables, graphs, figures, schematics, etc.--not only to obtain answers to immediate, specific questions but also for general comprehension and storage for use at a later time. A reading test that assesses a man's ability to deal with the variety of printed materials and the purposes for reading in the Navy is needed to diagnose specific reading deficiencies and to determine the effects of job training and job experience on the ability to perform these tasks.

2. Research should be undertaken to determine the effects of a reading skill-reading difficulty gap on both training and job performance. The present results indicate a large disparity between reading skill and reading requirements, but do not indicate the consequences of such a disparity.

3. A reading skill specification for accession into the Navy should be developed and implemented. The specification should be based on the general (i.e., recruit and apprentice) reading requirements. The determination of the cutoff score must consider effects on both the number of accessions and the racial distribution of accessions.

REFERENCES

Aiken, E. G., Duffy, T. M., & Nugent, W. A. Reading skills and performance in a sample of Navy Class "A" schools (Tech. Rep. 77-28). San Diego: Navy Personnel Research and Development Center, April 1977. (AD-A038 535)

Binkin, M., & Johnston, J. All volunteer armed forces: Progress, problems, and prospects, Brookings Institute Report, June 1973.

Biersner, R. J. Reading grade levels of Navy rate training manuals and nonresident career courses (CNET Rep. 2-75). Pensacola, FL: Chief of Naval Education and Training, May 1975.

Carver, R. P. Measuring the reading ability levels of Navy personnel (Tech. Rep.). Washington, DC: Office of Naval Research, October 1974a.

Carver, R. P. Measuring the reading difficulty levels of Navy training manuals (Tech. Rep.). Washington, DC: Office of Naval Research, September 1974b.

Fletcher, J. D., Duffy, T. M., & Curran, T. E. Historical antecedents and contemporary trends in literacy and readability in the Navy (NPRDC TR 77-15). San Diego: Navy Personnel Research and Development Center, January 1977. (AD-A035 582)

Gates, A. I., & MacGinite, W. H. Gates-MacGinite reading tests, Survey D. New York: Teachers College Press, 1965.

Harnischfeger, A., & Wiley, D. E. Achievement test score decline: Do we need to worry? Monograph. Chicago, IL: CEMREL, Inc., December 1975.

Hoiberg, A., Hysham, C. J., & Berry, N. H. The neuropsychiatric implications of illiteracy: 20 years later (Rep. No. 74-20). San Diego: Neuropsychiatric Research Unit, February 1974.

Kincaid, J. P., Fishburne, R. P., Jr., Rogers, R. L., & Chisom, B. S. Derivation of new readability formulas for Navy enlisted personnel (Automated Readability Index, Fog Count, and Flesch Reading Ease Formula) (NTTC-RBR 8-75). Millington, TN: Chief of Naval Technical Training, Naval Air Station, Memphis, 1975.

MIL-M-24100B. Military specification: Manuals, technical functionally oriented maintenance manuals (FOMM) for equipment and systems. January 1974.

Muller, W. Review of Navy research on the usability of technical manuals. In T. G. Sticht & D. Zapf (Eds.). Reading and readability research in the Armed Services (HumRRO FR-WD-CA-76-4). Alexandria, VA: Human Resources Research Organization, September 1976.

Northcutt, N., Selz, N., Shelton, E., Nyer, L., Hickok, D., & Humble, M. Adult functional competency: A summary. Austin, TX: University of Texas, March 1975.

Post, T. J., & Price, H. E. Requirements and criteria for improving reading comprehension of technical manuals (Tech. Rep.). Washington, DC: Naval Sea Systems Command, 1974.

Sticht, T., Fox, L., Hauke, R., & Zapf, D. The role of reading in the Navy (Tech. Rep. 77-40). San Diego, CA: Navy Personnel Research and Development Center, September 1977. (AD-A044 228)

Sticht, T., & Zapf, D. Reading and readability research in the Armed Services (HumRRO FR-WD-CA-76-4). Alexandria, VA: Human Resources Research Organization, September 1976.

Sulit, R. A., & Fuller, J. J. Navy technical manual system (NTMS) program summary (TM-186-76-1). Bethesda, MD: Naval Ship Research and Development Center, March 1976.

Young, K., & Jamison, D. T. The economic benefits of schooling and reading competence (Rep. RB 75-19). Princeton, NJ: Educational Testing Service, May 1975.

REFERENCE NOTES

1. Duffy, T. M., Carter, J. D., Fletcher, J. D., & Aiken, E. G. Language skills: A prospectus for the naval service (NPRDC Spec. Rep. 76-3). San Diego: Navy Personnel Research and Development Center, October, 1975.

2. Special training program (Unpublished Rep.). Washington, DC: Bureau of Naval Personnel, 1951.

3. Singer, H. IQ is and is not related to reading. Paper presented at the Annual Meeting of the International Reading Association, Denver, CO, May 1973.

4. Kulp, M. J. The effects of position practice readability level on performance. Unpublished Master's Thesis, San Jose State University, November 1974.